
Bioameliorant: Soil Amelioration and Nutrient Distribution in Organosol Soil Through the Application of Macro and Micro Fertilizer to Optimizing on the Growth of Rubber Trees (*Hevea brasiliensis* Muell. Arg.)

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ABSTRACT

Soil Ameliorants are materials used to improve soil, playing a key role in rehabilitating and enhancing the physical, chemical and biological properties of the soil. In the Organosol soil under study—commonly referred to as Histosol or Peat soil—the soil-improving materials play a vital role, as this soil is highly acidic, has very low levels of macro- and micro-nutrients, and contains organic acids that can be toxic to plants. The distribution of nutrients studied in Organosol soil shows a concentration of organic matter in the upper layer of the Organosol, where abundant nitrogen is bound organically; however, phosphorus, potassium, calcium and magnesium are very low due to leaching processes. In this study, the application of organic matter that supports microbial activity in Organosol soil—specifically the application of oil palm frond ash—can increase potassium (K) levels and soil acidity (pH), whilst the application of soil ameliorants can improve nutrient deficiencies in phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), demonstrating a significant and pronounced effect when applied to Organosol soil.

Keywords: *Ameliorants, Histosols, Peat, Organosols, Nutrient Distribution*

INTRODUCTION

Soil ameliorants are materials used in soil improvement, consisting of both organic and inorganic substances, which are applied to enhance the physical, chemical, and biological properties of the soil. The objective of applying soil ameliorants is to transform degraded or infertile land used for crop cultivation into soil

that is rich in nutrients and fertile. In line with the views of Anshori *et al.* (2021) and Elfarisna *et al.* (2023), the application of soil ameliorants serves to enhance soil fertility and improve degraded and infertile land by addressing its physical, chemical and biological properties.

The primary function of soil amendments is to improve the physical, chemical and biological properties of the soil; in terms of

physical properties, they increase soil porosity, improve aeration and enhance water retention; in terms of chemical properties, they neutralize soil acidity (pH), provide nutrients, and neutralize toxins such as heavy metals in the soil. In terms of soil biological properties, it serves as a food source for beneficial microbes in the soil. According to the research findings of Siregar *et al.* (2026), Ultisol is a soil order characterized by low soil acidity, low organic matter and nutrient content, and very low soil aggregate stability. Consequently, to improve these soil properties, it is necessary to apply soil amendments, one of which is the application of soil ameliorants.

Soil ameliorants are materials that can enhance soil fertility and health and improve soil properties; consequently, the materials used for soil amelioration consist of Organic matter combined with In-Organic materials. According to Barutu (2022) and Elfarisna *et al.* (2023), the combination of Organic and In-Organic materials can rapidly address issues in degraded soil whilst enhancing soil fertility and health. Examples of Organic materials include manure and straw, whilst In-Organic materials include Dolomite, Zeolite, and Volcanic ash.

The distribution of nutrients in the soil has specific characteristics: nutrient levels accumulate naturally in the top soil, but are easily leached away, meaning that nutrients are not readily available to plants; furthermore, the soil has a very low pH (soil acidity) level.

Nutrient distribution is influenced by distribution patterns, both vertical (depth-related) and horizontal (peat formation and water flow patterns). Based on depth (Vertical) patterns, nutrient distribution in Organosol soils is influenced by the depth of the Organosol and the degree of weathering, whilst based on

Horizontal patterns, nutrient distribution is determined by the type of peat formation and local water flow, which are influenced by the soil's nutrient status (*Ombrogen*) and mineral sedimentation from water flow (*Topogen*).

Generally, nutrient levels that are available and can be absorbed by plants are found in soil with a pH (soil acidity) between 5.0 and 7.0. However, in practice, many soils have a pH (soil acidity) below 5.5. Therefore, to raise the soil pH (soil acidity) in Organosol soils, agricultural lime (Dolomite) is used. In line with Edi (2022) in Elfarisna *et al.* (2023); Fidela *et al.* (2024) state that agricultural lime (Dolomite) has two benefits in the soil: it plays a role in raising the pH and acts as a source of calcium (Ca) and magnesium (Mg). According to Wahyuningsih and Cundari (2024), an increase in the concentration of hydrogen ions in the soil will increase the soil's acidity level or reduce soil acidity.

In general, the distribution of nutrients in rubber plantations (*Hevea brasiliensis* Muell. Arg.) on Organosol or Histosol (peat) soils is characterized by a very high organic matter content, but very low levels of macro- and micro-nutrients. This is because nutrients accumulate in the topsoil and are easily leached; therefore, management requires fertilization, raising the low soil pH, and adding soil amendments to restore soil fertility and achieve optimal productivity.

Therefore, in this study, it is necessary to examine and improve Organosol soils by optimising nutrient availability and distribution, and by managing Organosol soils which requires the addition of soil amendments to improve soil properties and structure in rubber plantations (*Hevea brasiliensis* Muell. Arg.).

MATERIALS AND METHODS

This study was conducted over a period of five months, from September 2025 to January 2026, on the rubber plantation of PT. Sampit International, located in Ketapang Village,

Mentawa Baru Ketapang Sub-district, East Kotawaringin Regency, Kalimantan Tengah.

This study employed a non-factorial Randomised Block Design (RBD) with three factors, wherein Factor 1 had one treatment

level: Level 1 involved the collection of Organosol soil samples (*initial soil*) at a depth of 0–20 cm from rubber plantations, Factor 2 has 2 treatment levels: Level 1 involves the application of an ameliorant in the form of 2000 g.planting hole⁻¹ of matured mixed Organic Fertilizer near the rubber trees; Level 2 involves the application of compound fertilizer N.P.K. + Mg + CaO at a ratio of 16.16.16 + 0.5 + 6, with a dose of 500 g.planting hole⁻¹. Factor 3 has one treatment level, namely Level 1: a mixture of the soil ameliorant and N.P.K + Mg + CaO compound fertilizer with a percentage ratio of

16.16.16 + 0.5 + 6, applied at a dose of 1,000 g.planting hole⁻¹.

Soil analysis was carried out at the Soil Laboratory to determine the soil organic carbon (Organic C) content (%), total soil nitrogen (Total N) content (%), phosphorus content (P₂O₅-avl (P-Bray I) (ppm P)), potassium content (K₂O potential, HCl 25%), soil acidity (pH H₂O), CaO content (HCl 25%) (%), and MgO content (HCl 25%) (%).

RESULTS AND DISCUSSION

1. Initial Soil Analysis – Organosol Soil

The results of the initial soil analysis (Organosol soil) are shown in Table 1 below:

Table 1. Initial Soil Analysis – Organosol Soil

Texture	Method of Analysis	Units	Results	Description
C-Organic	Spectrofotometry	%	4,96	h
N-Total	Kjedhal	%	0,58	h
P ₂ O ₅ -avl (P-Bray I)	Spectrofotometry	ppm P	1,90	vl
K ₂ O Potential Ex. HCl 25%	AAS	me.100 g ⁻¹	0,12	vl
pH H ₂ O	Electrometry	----	4,5	<i>Sour</i>
CaO Ex. HCl 25%	Gravimetry	%	0,09	l
MgO Ex. HCl 25%	AAS	%	0,08	l

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High, nm = Not Measurable

The results of the analysis carried out at the Soil Laboratory regarding the testing of initial nutrient levels in Organosol soil showed that the Organic Carbon (C-Organic) and total nitrogen (N-Total) levels were high. The Organic Carbon (C-Organic) content was found to be 4.96%, whilst the total nitrogen (N-Total) content was 0.58%. This indicates that Organosol soil possesses

a high nitrogen nutrient level and a high organic matter content, as evidenced by the Organic Carbon analysis results.

2. Final Soil Analysis – Organosol Soil

The results of the final soil analysis (Organosol soil) are shown in Tables 2 Tables 3 and Tables 4 below:

Table 2. Final Soil Analysis – Organosol Soil

Soil Amandment Treatment				
Texture	Method of Analysis	Units	Results	Description
C-Organic	Spectrofotometry	%	4,93	h
N-Total	Kjedhal	%	0,61	h
P ₂ O ₅ -avl (P-Bray I)	Spectrofotometry	ppm P	12,10	h
K ₂ O Potential Ex. HCl 25%	AAS	me.100 g ⁻¹	1,21	h
pH H ₂ O	Electrometry	----	6,6	<i>Neutral</i>
CaO Ex. HCl 25%	Gravimetry	%	0,20	m
MgO Ex. HCl 25%	AAS	%	0,19	m

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High, nm = Not Measurable

Table 3. Final Soil Analysis – Organosol Soil

Application of Fertilizer N.P.K + Mg + CaO (16.16.16 + 0,5 + 6)				
Texture	Method of Analysis	Units	Results	Description
C-Organic	Spectrofotometry	%	4,93	h
N-Total	Kjedhal	%	0,59	h
P ₂ O ₅ -avl (P-Bray I)	Spectrofotometry	ppm P	11,15	h
K ₂ O Potential Ex. HCl 25%	AAS	me.100 g ⁻¹	1,05	h
pH H ₂ O	Electrometry	----	6,9	<i>Neutral</i>
CaO Ex. HCl 25%	Gravimetry	%	0,25	h
MgO Ex. HCl 25%	AAS	%	0,23	h

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High, nm = Not Measurable

The results of soil analysis at the soil laboratory show changes in nutrient levels in the Organosol soil following the application of soil ameliorants and In-Organic fertilizer at a ratio of 16-16-16 + 0.5 + 6. These results, shown in Table 2, indicate a 3% increase in the percentage of total soil nitrogen (N-Total). The increase in total soil nitrogen triggered a 3% decrease in soil organic carbon content. This is because the decrease in carbon content can occur as the organic matter present in the Organosol soil undergoes weathering or decomposition,

actively breaking down into Carbon-dioxide (CO₂).

Meanwhile, the results of the analysis in Table 2 show that the total nitrogen content of the soil increased by 1% and the organic carbon content decreased by 3%. In this situation, the availability of nutrients supplied to the Organosol soil results in a decrease in the soil's carbon/nitrogen (C/N) ratio, thereby making the available nutrients in the soil more readily absorbed by plant roots, including those of the rubber tree (*Hevea brasiliensis* Muell. Arg.). In

optimizing the growth of the rubber tree (*Hevea brasiliensis* Muell. Arg.) and its impact on the soil, in Organosol soil that is deficient in macro- and micro-nutrients, the application of soil ameliorants and macro- and micro-fertilizers will have a positive effect, demonstrating that the application of soil ameliorants and macro- and micro-fertilizers is effective. In this process, microbes in the Organosol soil break down carbon as an energy source and utilize nitrogen for microbial protein synthesis, thereby releasing carbon into the atmosphere.

According to Salsavira (2024), changes in the levels of organic carbon (C-Organic) in the soil are influenced by various factors, including the gradual decomposition of organic matter and an increase in the total nitrogen content of the soil resulting from the application of soil ameliorants and In-Organic macro- and micro-fertilizers.

The results of the macro-nutrient analysis showed an increase in soil phosphorus and soil potassium levels. This demonstrates the role of the soil ameliorant in Organosol, clearly evidencing an increase in nutrient content. According to Sukaryorini *et al.* (2019) as cited in Abdila *et al.* (2022), organic carbon (C-Organic) content is caused by the presence of organic matter in the soil, or organic matter added to the soil, resulting in the presence of organic carbon (C-Organic); however, a decrease in organic carbon (C-Organic) levels occurs because the organic matter has undergone decomposition, leading to reduced organic carbon levels and an increase in total soil nitrogen.

Meanwhile, according to Yosephine *et al.* (2022) and Lubis *et al.* (2023), the application of soil ameliorants improves soil quality because these substances play a role in enhancing the physical, chemical and biological properties of the soil. Lubis (2020) states that if the application of soil ameliorants results in an increase in the levels of phosphorus (P) and potassium (K), this indicates that the application has successfully transformed the environment and the Organosol, making previously unavailable nutrients available and easily absorbed by plant roots.

The results in Table 3 show that the increase in nutrient levels in the Organosol soil was due to the application of compound fertilizer. This is because the application of compound fertilizer in Organosol soil ensures that nutrient levels are sufficient; whilst Organosol soil naturally has a high organic matter content, the levels of phosphorus (P) and potassium (K) are often low, leading to a situation where these nutrients are fixed or easily leached, making them difficult for plant roots to absorb.

According to Saputra (2024) as cited in Lubis and Pakpahan (2026), the study states that the application of compound fertilizer to Organosol soil resulted in increased levels of phosphorus (P) and potassium (K), meaning that the fertilization efforts successfully supplemented and met the requirements for macronutrients that were initially unavailable but have now become available.

Table 4. Final Soil Analysis – Organosol Soil

Soil Ameliorants Treatment + Fertilizer Treatment N.P.K + Mg + CaO (16.16.16 + 0,5 + 6)				
Texture	Method of Analysis	Units	Results	Description
C-Organic	Spectrofotometry	%	5,25	h
N-Total	Kjedhal	%	0,72	h
P ₂ O ₅ -avl (P-Bray I)	Spectrofotometry	ppm P	13,22	h
K ₂ O Potential Ex. HCl 25%	AAS	me.100 g ⁻¹	1,72	h
pH H ₂ O	Electrometry	----	7,2	<i>Neutral</i>
CaO Ex. HCl 25%	Gravimetry	%	0,29	h
MgO Ex. HCl 25%	AAS	%	0,28	h

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High, nm = Not Measurable

The results of the soil analysis, as shown in Table 4, indicate that this treatment involved a mixture of the soil ameliorant treatment and the compound fertilizer treatment (NPK + Mg + CaO 16.16.16 + 0.5 + 6). The results of this mixture show that the Organic Carbon (C-Organic) nutrient content increased significantly by 29% and the total soil nitrogen content rose by 14%. This indicates that the application of a mixture of Ameliorant and Compound Fertilizer has a positive impact on soil property improvement and soil fertility. This treatment was followed by an increase in phosphorus (P) and potassium (K) levels. This indicates that the Organosol soil now contains sufficient nutrients, or in other words, the application of the mixture has made the Organosol soil more fertile.

CONCLUSION

In conclusion, the results of this study indicate that the application of a mixture of the soil ameliorant treatment and the compound fertilizer treatment N.P.K + Mg + CaO (16.16.16 + 0.5 + 6) has a positive effect on Organosol soil, which is deficient in macro- and

According to research by Lubis (2026) and Prihantoro *et al.* (2023), Organosol (peat) soil is known for being extremely nutrient-poor, making it unsuitable for crop cultivation; however, following the application of Organic matter and In-Organic fertilizers, Organosol soil exhibits an increase in nutrient content and the availability of nutrients within the soil.

For rubber trees (*Hevea brasiliensis* Muell. Arg.), phosphorus (P) and potassium (K) are vital nutrients that optimize vegetative growth, cell division, and maximize the production and quality of the latex produced. According to the findings of Achmad and Putra (2020), potassium stimulates root growth and energy transfer, whilst directly influencing the volume of latex produced.

micro-nutrients; but following the application of the mixture, nutrient levels increased, making nutrients available in the Organosol soil for the growth and yield of rubber trees (*Hevea brasiliensis* Muell. Arg.).

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